**Motor Sports Racing Update**
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*It is easy for the do-it-yourselfer to port cylinder heads. All you need is the Standard Abrasives Deluxe Porting Kit, some common tools and some free time.*

# Head Porting for the Do-It-Yourselfer

**by the technical staff of**
**Standard Abrasives Motor Sports Division**

Here's an interesting head porting fact: In many cases, the greatest performance gain per dollar spent comes upon application of basic porting procedures to a production cylinder head.

These basics can be done by any do-it-yourselfer, even those with no porting experience, using the Deluxe Porting Kit and the Gasket Removal Kit (part nos. 260001 and 260005) from the Standard Abrasives Motorsports Division, along with a die grinder and some common hand tools.

There is a significant difference between basic head porting for a street-high-performance or weekend racer application and the very complex cylinder head work you see in a Pro Stock drag race motor or a NASCAR Winston Cup race engine. Doing full-on race heads requires the services of an experienced cylinder head professional, so Pro Stock, Winston Cup and similar heads are best left to experts. Basic head porting, however, is easy...so easy that even beginning hot rodders can do it well.

Basic cylinder head porting will improve the performance of any production cylinder head by removing flaws that come through mass production. Basic porting does not attempt to correct any design or engineering deficiencies. Once your porting project turns to that, you're beyond the scope of basic porting techniques.

*The components of the Porting Kit are neatly packed in a compartmented box. There are enough abrasive materials to port a set of V8 heads.*

Why is basic port work important to your engine's performance? It reduces the restriction in the engine's intake and exhaust tracts. Reduce that restriction and you let more air into the cylinders. If you have more air, you can add more fuel. The result is increased horsepower.

*The area of the valve guide that protrudes into the intake or exhaust port is always a place where sharp edges and restriction to flow are found. A basic porting project seeks to smooth those sharp edges.*

*A more significant point of restriction is where the intake or exhaust port floor curves down to meet the valve seat. Called the "short side radius," it is also a place where sharp edges and roughness pose a threat to flow. In this cutaway of a production cylinder head, the short side radius has not one but two very sharp edges.*

Most of the work in a basic porting project is focused on reducing those restrictions which are caused by: 1) "steps" that may obstruct intake air flow as it transitions from the intake manifold to a smaller intake port entry in the head; 2) casting bumps, ridges or other marks, such as those you may find on port floors or roofs; 3) sharp edges, such as those you will find around the valve guide bosses at the top of the valve pockets; and 4) the point where the intake port floor curves down to the valve seat.

Basic porting, while somewhat time consuming, is not hard work. It takes about 10-12 hours to do a set of average V8 heads. Some week nights and a weekend invested in your heads and your basic porting project will be complete.

Time is money, so we are not going to tell you doing your own heads will save a lot; however, most professional cylinder head porting businesses will charge $400-$600 for what is sometimes known in the trade as a "street/strip" port/polish job. Your basic porting project, done with the Standard Abrasives Porting Kit, will allow you to spend that $400-$600 on some other performance enhancement you want.

The project is made up of six sub-tasks:

1. Intake port entry enlargement, surface finishing and port matching.
2. Smooth the intake short side radii, valve guides and valve pockets.
3. Smooth the exhaust short side radii, valve guides and bowls.
4. Exhaust port and bowl polishing.
5. Combustion chamber polishing.
6. Intake manifold port matching.

Five of these six tasks reduce restriction in the intake and exhaust tracts. The remaining step, polishing the combustion chambers, inhibits carbon build-up, decreasing an engine's tendency to detonate or "knock" under heavy load.

After we touch on materials, tools and safety precautions, we are going to walk you through the specifics of a basic port job. As an example, we'll port a standard cast iron head as used on a 5.0-liter Chevrolet Small-Block V8; however, all basic porting techniques can be applied to the head or heads on any engine, regardless of its manufacturer, configuration or number of cylinders.

To illustrate the improvement that comes with basic porting work, at the end of this web page, we'll post flow test results, both before and after porting,

## Materials, Tools and Safety

***This display shows all the items one needs to port a set of heads the easy, Standard Abrasives way.***

The first items you need are our Standard Abrasives Deluxe Porting Kit and our Standard Abrasives 3-inch Gasket Removal Kit. These contain all the abrasive products required to perform a basic porting job on a pair of cast iron or aluminum cylinder heads.

The components in these kits are designed for mounting in a die grinder having a maximum speed of 18,000-20,000 rpm and a 1/4-in. diameter collet or "chuck." Do not use an 1/8-inch collet grinder of the type used in hobby or arts and crafts work.

An air-powered die grinder is desirable because of its relatively low cost and variable speed. An air grinder will require a compressed air source. Most compressors powered by motors rated at 2.5 horsepower or more will work well. The air system should be equipped with an adjustable pressure regulator. The abrasive products' maximum safe speed is 18,000-20,000 rpm. If an air grinder's maximum rpm exceeds that, **you must reduce the air pressure with the regulator so that speed is not exceeded.**

***This particular air compressor has a built-in pressure regulator. The pressure control on the panel selects the regulated pressure. The gauge on the panel reads regulated pressure not the tank pressure. If you use an air grinder, whatever compressed air source you use should have an adjustable regulator.***

While the never-exceed speed is 18,000-20,000 rpm, best durability of the abrasive products is achieved when the grinder runs at 10,000-12,000 rpm. Obviously, measuring the die grinder's speed is difficult; however, most tool manufacturers cite the maximum speed either in the unit's instructions or on a specification plate attached to the tool. Suppose maximum speed of your unit is 20,000 rpm, but you want to run it at 10,000. Operate the grinder at half throttle and listen to the noise it makes. Then, run it at full throttle and adjust the pressure regulator such that the noise is about the same as before. That will approximate 10,000 rpm.

The pressure regulator is important for another reason. You hold a die grinder in both hands, one on the rear of the tool and the other on the front of the unit. The front hand controls the grinder and operates the throttle. It is easier to manipulate a die grinder with the throttle wide open than it is to both control the grinder and modulate the throttle at the same time.

You may be using an electric die grinder. That is acceptable as long as its maximum rpm is below the 18,000-20,000 rpm limit. Because electric grinders are often capable of exceeding that by a significant margin, an electrical device allowing the user to reduce the tool's speed is necessary. Additionally, speed regulation of an electric grinder will be necessary if you want to use the abrasives at 10,000-12,000 rpm.

Additional tools and materials required are: A 5/64-in. hex key (Allen wrench), the die

grinder's chuck wrenches, a set of the intake manifold gaskets you will use when you assemble the engine, a set of intake manifold bolts, a scribe, machinist's bluing (either brush-on or spray-on), a pair of four-inch long 2x4 wood blocks and junk intake and exhaust valves that fit your heads.

None of the techniques used in a basic porting project are dangerous when proper safety procedures are followed; however, misuse of the tools or failure to observe safety procedures may result in injury.

Porting work throws lots of metal chips around, so the first thing you need to protect are your eyes. The minimum protection is shatterproof eye wear designed for industrial use. Better is a set of goggles with a shatterproof lens. Best is a face shield made of shatterproof material.

Next, you need snug-fitting work gloves. We recommend the Mechanix Wear brand since they allow a good sense of touch while still offering protection. An alternative is a generic leather work glove of medium thickness. Avoid thin leather gloves or the very thick units intended for welding. Do not use rubber gloves.

The last two pieces of safety equipment are optional but suggested. People sensitive to airborne dust may want a respirator mask such as the type used by paint and body shops. These inexpensive, white cloth masks are held to your face with an elastic string.

The noise some air grinders make is quite loud. If the loud power tools are a discomfort, do your port work wearing ear protection. Best are the muffs airport workers wear around jet engines. Acceptable are a set of ear plugs intended for industrial use.

Mechanix gloves can be found anywhere racers buy parts and supplies. You should be able to find the rest of this safety equipment at a hardware store. Dedicated safety vendors, such as Lab Safety Supply, are also good sources.

You need a waist high work bench with about a three-foot by five-foot area of clear space. Consider the lighting of your work area, too. Gauging the quality of your porting depends on you being able to easily see the work. If your garage or other work area is dimly lit, consider investing in some fluorescent shop lights or at least some temporary, auxiliary lighting.

As this project will probably extend over several days, you will want to clean up the work area from time to time. Know that under certain conditions, aluminum dust is a fire hazard. Dispose of aluminum particles and dust in a covered container.

If you have never used a die grinder to deburr, port or polish engine parts, we suggest you obtain a junk head and try a bit of grinding with some of the abrasive products in the Standard Abrasives Porting Kit before you start on the heads from your engine. What you want for your practice session is a head that is damaged or otherwise unserviceable. Sources for this are wrecking yards and automotive machine shops. Best bet is to get a head similar to the one on which you are going to do your basic port work.

The point of this exercise is to get a feel for the die grinder fitted with different tools. Prior to starting your practice, use the wood blocks to support the head in a manner that makes the head deck and intake and exhaust port surfaces easy to reach. Lift up the head and place a block between your work bench and a head bolt boss or other surface of the head that will sit on the block.

The first die grinder operation to learn is

changing tools. Virtually all die grinders come with a set of wrenches used to loosen and tighten the chuck. Typically, one wrench holds the air grinder shaft and the second wrench turns the chuck's nut. You loosen the nut, insert the tool, then tighten the nut. In the process of your basic porting project, you will change the tool many times. Always disconnect the air grinder from the air source and the electric grinder from the power source when changing tools.

***Tool changing is the first die grinder skill one learns. Most die grinders use the type of chuck that is tightened with two open-end wrenches.***

During your practice work, learn to control the grinder such that you move it smoothly. Grinding in one place will result in removal of too much material and uneven surfaces. Also, this is the time to set the speed of the grinder. You neither want to exceed 20,000 rpm nor do you want the grinder to chatter. Remember, best speed is 10,000-12,000 rpm. Review the previous discussion about grinder speed if you need to change it.

If you are working with aluminum heads or intake manifolds, regardless of the type of abrasive, use a more gentle touch than you would if you were working cast iron. Because aluminum is softer than iron, it abrades faster. If you use the same grinder pressure you would with iron, before you know it, you will have shaved off too much material. Additionally, under most conditions, the abrasive tool will "load- up" with caked on aluminum as you work. Spraying the tool frequently with a light lubricant, such as WD-40, reduces this problem.

Throughout this job, your quality control device will be your finger. During your practice work, find a reasonably flat spot on the exterior of the head. Use the 40-grit then 80-grit cartridge rolls to smooth a square-inch or so of this area. Use the exterior of the head because you want your finished work to be easily visible. Strive for an even finish with the 80-grit. Then, take off your gloves and use your finger tips to feel the area you have just prepared. Think carefully about what you are feeling. Hold that thought.

After you feel confident you have had enough practice on the junk head, lay out the "good" heads you will port on the bench. They need to be completely disassembled before any port work is attempted. Consult a factory service manual if you are going to take them apart yourself or have an automotive machine shop do it for you.

After disassembly, if the heads came off an engine that had been in service a while, they will need to be cleaned. We suggest you have iron heads hot-tanked. If your heads are aluminum, make sure whatever cleaning method you choose is safe for aluminum.

Used heads should be carefully examined for cracks, especially around the exhaust valve seats. Additionally, used heads should be pressure checked to make sure they have no coolant leaks. If leaks or cracks are found, have them repaired before doing any port work.

## Step 1: Removing Old Gaskets and Marking the Intake Ports

***Even after it was hot-tanked, this cylinder head still has very dirty intake gasket surfaces. Most used heads will come out of the hot-tank or cleaning bath this way. Note the sharp-edged***

***"step" formed by the corners of the port entry in the head.***

Even though the heads have been cleaned, the gasket and deck surfaces should be conditioned to remove all traces of old gaskets, paint, gasket sealer, corrosion and dirt. The use of a putty knife or scrapper for this purpose is not acceptable because neither will clean those surfaces completely. If your heads are aluminum, a putty knife or scraper may even damage those surfaces.

***The solution is the Surface Conditioning discs in Standard Abrasives Gasket Removal Kit. They abrade the surface down to bare metal but do no damage in the process.***

The Standard Abrasives' 3-inch Gasket Removal Kit is the proper way to condition the gasket surfaces without damaging them. It contains surface conditioning discs for use on cast iron and aluminum along with a holder pad that attaches to your die grinder.

Disconnect the grinder, install the Standard Abrasives' surface conditioning disc holder into the chuck and tighten the nut. The conditioning discs use Standard Abrasives' unique Soc-Att™ locking system, so installation is as simple as a twist of your wrist. Reconnect the grinder, put on your eye protection and gloves, then start removing the gaskets the easy, Standard Abrasives way. Once the gasket surfaces are down to bare metal, disconnect the grinder and remove the conditioning disc set-up.

In most cases, your port work will start with enlarging the "port entry" area to the size of the openings in the intake manifold gaskets. Later, you will reshape the ports in the intake manifold to this same size.

To ensure the head port entry and the intake manifold port end up the same size, you scribe an outline of the intake gasket openings on the head and the manifold. Machinist's bluing is used for this. Apply it to the intake gasket surface around the intake ports and allow it to dry. Place the new intake gasket in its normal position and hold it with manifold bolts. Scribe the inside perimeter of each intake port onto the gasket surface of the head, then remove the gasket.

***Machinist's blue, in this case spray-on Dykem, is applied to the area surrounding the intake port entries in the head.***

***The intake manifold gaskets, in this case a set of Fel-Pro Performance Gaskets, are installed on the head. Intake bolts hold them in place and an outline of the inside of the gasket's intake port is scribed on the head.***

***The areas inside of the scribe lines are the places where material will be removed.***

Pay close attention to the position of the gasket on the head. If it is upside down or backwards, your scribe marks will be in the wrong locations. That will cause a serious problem with your port work.

## Step 2: Preparing the Intake Port Entry

Install the large, conical, rotary grinding stone (part no. 263901) from the Porting Kit into the grinder's chuck. Tighten the chuck then reconnect the air hose or electric cord. Remember to put your eye protection back on if you remove it during the change.

***The first porting operations are usually done with the rotary stone.***

Now you are ready to do your first porting work. You will enlarge the port openings in the intake gasket surface by removing material inside of the scribe marks you made. Then, you'll blend or "feather" the now larger port opening into the remaining port by removing progressively less material as you move down into the intake port. In most cases, you want to grind from the port entry to about 1-1.5 inches into the port.

***When using the stone, remember that 1) it removes material quickly and 2) smooth, controlled movement of the grinder is necessary.***

From your initial practice on the junk head, you know that the stone removes large amounts of material rather quickly so pay attention to control of the grinder. It is better to go over the work with several light-to-moderate passes rather than doing one heavy pass, remove too much and possibly render the head useless.

Certain heads, such as Chevy small-block V8 units, have pushrod holes in close proximity to the port wall, just downstream of the port entry. Enlarge the port entry too much and you will grind into a pushrod hole. This may destroy the head or at least cause a very expensive repair. Adequate work on the practice head will help you avoid that.

To see how far you can enlarge the port, go back to the junk head and grind one of its port entries until you cut into the pushrod hole. After that, you will know how much you can grind in that area without damaging the head.

Once you have removed the majority of material with the large stone, you may need to switch to the small diameter, conical rotary stone (part no. 263061) to profile the small radii at the corners of each port.

The most important thing to remember about rotary stones is they remove large amounts of material. They are not for final surface finishing. There may be basic port projects that do not require removal of large quantities of material. An example might be a production head on a high-performance engine. Those heads may already have fairly large ports and you will find the material to be removed inside the scribe marks is minimal. In that case, the rotary stones may be unnecessary.

Disconnect the grinder, remove the stone and install the short cartridge roll mandrel (part no. 269111). Cartridge rolls come in a variety of sizes and shapes. The Kit includes straight rolls in two grits and three diameters, half-taper rolls in two grits and two diameters and full-taper rolls in two grits. Different grits are necessary to get the proper finish. Cartridge roll work starts with 40-grit then switches to 80-grit. It is not practical to go from a virgin surface or one that has been worked on with the rotary stone to proper finish with only the 80-grit. It takes too much time and you'd need more 80-grit rolls than there are in the Kit.

***The Cartridge rolls in the Standard Abrasives Porting Kit come in a wide variety of shapes and sizes.***

Large-diameter, straight cartridge rolls are for finishing relatively flat

***Cartridge rolls also come in two grits, 80 (left) and 40 (right).***

surfaces like port walls, floors and roofs. The small straight rolls are for finishing long, radiused areas, such as the corners of intake ports, or areas of convex curves such as the corners of the valve guide bosses or the short side radii. The half-taper and full-taper cartridge rolls are better used on surfaces with concave curves, such as the "bowl" areas at the top of the valve pocket or combustion chamber corners. Additionally, half- and full- taper rolls are better to use when the tool approaches the work from a steep angle, such as working on the valve guide boss through the valve hole.

***The cartridge roll mandrel has threads that hold the roll. Each roll has an orange spot which is pointed at the grinder. All you do is push the cartridge roll on the mandrel, then screw it tight.***

With the mandrel in place and tightened, place one of the large, straight 40-grit cartridge rolls (part no. 263161) on the end of it. Note the little orange spot on one end of the roll. Point the spotted end towards the grinder, then screw the roll onto the mandrel. Reconnect the air or power supply.

***You start with 40-grit rolls and progress to 80-grit. In many intake ports, the small-diameter rolls will be needed to finish the radii at the corners of the port. Typically, you polish only 1-1.5 inches down the port.***

Begin finishing the flat areas in that first 1-1.5 inches past the port entry. Only work deeper in the port if there are excessive bumps or casting flaws. Remember to feather the smooth area into the surrounding virgin metal at the end of that 1-1.5-inches down the port entry.

Once you have worked the port entry with 40-grit, switch to the large, straight 80-grit cartridge roll (part no. 263163). The 80-grit gives you the smooth, but not polished, surface that is correct for intake ports. Once you finish the 80-grit step, stop, remove your gloves and feel the surface. When your tactile "QC checker" senses the right finish on all the port walls, you're done.

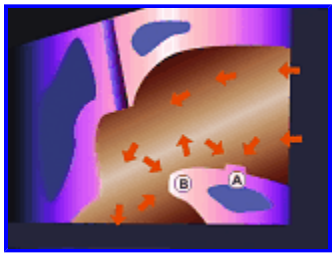
***Best way to gauge the finish on the port walls is with your finger. For intakes, you want the surface slightly rough to the touch but without waves, gouges or low spots.***

***At left is a finished intake port entry. Note the slightly rough finish. At right is a partially finished port. The floor is untouched and a large casting mark is evident. Also, note the difference in port heights. This is because the left port has been matched to the gasket whereas the matching of the right port has not been completed.***

***With this cutaway, we polished the whole port to better illustrate the rough-to-touch finish. Note the smoothed valve guides and short side radius.***

## Step 3: Short Side Radius and Bowl Work

The point where the intake port floor curves down to the valve seat is known as the "short-side radius." From an airflow standpoint, this area is the most critical in any port. Smooth that spot and there usually is a significant increase in flow through the port.




***(A) In this production intake port, air starts into the port flowing smoothly. When it encounters the casting bump on the floor of the port, smooth flow breaks into tumbling and turbulence. This causes restriction to the overall airflow in the port.***

***(B) The turbulence in the airflow becomes more severe as air passes the sharp edges of the short side radius in this drawing. Smoothing the radius and removing casting bumps and flaws reduces turbulence and increases flow.***

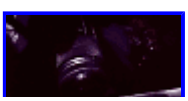
With most production heads, the short-side radius will be sharp-edged and rough. The goal is to soften those sharp edges and smooth the roughness. Depending on the location of the radius and how you are approaching it, you may keep the short mandrel in the grinder or you may need to switch to the long mandrel (part no. 269149). Start with the small diameter, 40-grit straight cartridge rolls (part no. 263021) and, depending on the location of the radius and the tool angles necessary to approach it, you may also need to use small, 40-grit, half-tapered (part no. 263351); large, 40-grit half-tapered (part no. 263751) or 40-grit, full-tapered (part no. 263301) cartridge rolls. Again, you start with 40-grit and switch to 80-grit.

***Bowl work is the second part of the basic porting. Here a half-tapered cartridge roll is used to smooth the valve guide. While this picture shows work on an exhaust port, the valve guide work is the same be it in an intake or an exhaust.***

Short side radius work is the first time you will bring abrasives near the valve seat and that is the one place you want to avoid hitting with any abrasive or rotating part of the grinder. Even though you will have a valve job done to your heads once the port work is finished, it doesn't take much of a hit on the valve seat to render it unusable even after a valve job.

The next step is to do the roofs of the valve pockets and the valve guide boss. Called "bowl work", this will require a mix of the different small-diameter, tapered and straight cartridge rolls. Remember to start with 40-grit and finish with 80.

The valve throat is the smallest diameter in the valve pocket just above the valve seat. A general rule is that the valve throat should be



***In some cases, depending on***

about 85% of the valve diameter. If you measure the throat to be smaller than that, using a combination of the rotary stone and cartridge rolls, open that diameter up to the 85% figure. If you attempt to open up the valve throat, first practice the technique on your junk head.

***port length and the position of the valve guide, it may be necessary to switch to the long cartridge roll mandrel and work on the guide through the intake port entry or the exhaust port exit. A full-taper cartridge roll works best for that.***

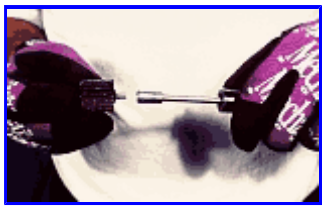
## Step 4: The Exhaust Port

Goals for the exhaust port are similar to those we achieved with the intakes: To reduce restriction to gas flow, but your methods are going to be a bit different.

Exhaust gases carry combustion by-products, of which carbon is a component. Over time, carbon deposits build up on the exhaust port walls and that can impede exhaust flow. To make the port walls more resistant to carbon build-up, in the final step you will give the exhaust port as smooth a texture as possible, a "near-mirror" finish, if you will.

The initial exhaust port work is very much like what you did to the intakes. The major part of the finishing and polishing will often be done with small-diameter, straight and tapered cartridge rolls. Do the port exits, bowls and valve guide work just like you did on the intakes.

***Initially, the exhaust port exits are worked just like the intake port entries; however, they are finished by polishing the full port and using finer than 80-grit abrasives.***



***After cartridge roll work is complete, you switch to the Combination Mandrel and attach the flap wheel.***

Once you are done with the cartridge rolls, remove their mandrel and install the Standard Abrasives Combination Mandrel (part no. 269201) and screw the 120-grit flap wheel (part no. 262618) onto it. The flap wheel is used to take the finish one step past what you put on the intakes. Use the flap wheel on every part of the exhaust port you can reach.

***You want to flap wheel all accessible areas of the exhaust port.***

Once your flap wheel work is done, remove it and install one of the small, hex-socketed set screws into the Combination Mandrel. Tighten it, then screw one of the maroon-colored, 3-ply, 1 1/2- inch, medium-grade, Cross Buffs™ (part no. 265054) onto the set screw. Standard Abrasives Cross- Buffs™ are the most unique product in the Deluxe Porting Kit. They were designed exclusively for automotive use. Of all abrasives in the Porting Kit, Cross Buffs ™ are most sensitive to grinder speed and should be run at 10,000 rpm for best results. Also, Cross Buffs ™ need to be used with a light lubricant, such as WD-40.

Begin working the exhaust port with the medium Cross Buff ™. Once you have hit as much of the port as you can with the medium, make a final pass with the red, 3-ply, 1 1/2-in. very-fine-grade, Cross Buff™ (part no. 265056). When you are done, the exhaust port walls will have that near-mirror finish that will resist carbon deposits.

***The Cross Buffs™ in the Standard Abrasives Porting Kit come in two grits; medium and fine.***

*When flap wheel work is done, an Allen stud goes in its place.*

*Cross Buffs ™ are screwed onto the Allen stud in the Combination Mandrel.*

*Use the Cross Buffs ™ just like you did the flap wheel; on all areas of the port you can reach. A light oil must be used with Cross Buffs ™.*

In most cases, you never port match the exhausts. Many stock exhaust manifolds and virtually all tube headers will have larger port sizes than do the heads. You want that "step" from the port to the larger header tube or exhaust manifold because, as pressure pulses flow back and forth in the exhaust system, it acts as a "reversion dam" by resisting back flow of exhaust gases into the port. If you end up with the rare situation where the stock exhaust manifold has ports smaller than those in the head, you will need to port match. Use the same technique used to match the intakes.

*This is a finished exhaust port. Note the smoothed valve guide and short side radius. Also, note the finish is significantly different from what we saw on the intake cutaway.*

## Step 5: Polishing the Chambers

You want to put the near-mirror finish on the combution chamber walls for two reasons: 1) As a deterrent to carbon build-up; and 2) to eliminate any sharp edges that can cause pre-ignition. The first thing to do is clean up the stems of your junk valves (Cross Buff ™ or one of the surface conditioning discs will work well) then install the valves into the chamber you will be working on. They will protect those all-important valve seats as you polish the surrounding chamber surfaces.

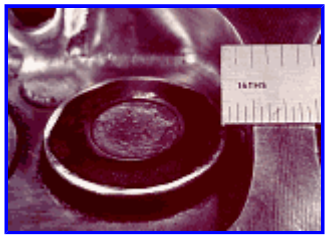
*Before doing the chambers, install a set of valves to protect the valve seats.*

Spray the head deck with machinist's bluing, then install one of the head gaskets you will use to assemble the engine. Scribe the outline of each chamber hole in the gasket on the deck.

Most important to remember during chamber work is that you want to remove as little material as possible. Every bit of metal you polish away increases chamber displacement a tiny bit and reduces your compression ratio a corresponding amount. For that reason, you must not use the rotary stone for chamber polishing unless you need to unshroud the exhaust valves.

Nevertheless, you cannot polish the chambers with just Cross Buffs ™. You must use the cartridge rolls first. Next, smooth the sharp edges where the chamber meets the deck, but do not grind past the line scribed around the chamber. You may need the larger cartridge rolls for the chamber's flat surfaces.

*Half-tapered cartridge rolls are best to polish chamber corners.*



***This particular head did not have an exhaust valve shrouding problem; however, heads with small chambers and big valves may have the problem. The easiest way to check for it is to hold the valve open about 3/8-inch and use a ruler to measure the distance between the valve edge and the chamber wall.***

Exhaust valve "shrouding" occurs when, at high valve lifts, exhaust flow is impeded by the closeness of the chamber walls to the edge of the open exhaust valve. Shrouding is common with pre-1971 Chevrolet small- and big-block V8 and early 289/302 Ford Windsor heads. At .300-.400 valve lift, there should be 3/16-in. or more between the edge of the valve and the adjacent chamber walls. If you do lack 3/16-in. clearance and there is material between the edge of the chamber wall and the gasket opening scribed on the head; remove material along the chamber wall such that exhaust valve shrouding is reduced. Only remove material inside the scribe line and only enough to achieve the clearance.

Once your chamber work with cartridge rolls is complete, go over all surfaces with the 120-grit flap wheel. Finally, do the chamber with, first, the medium Cross Buff™ and then, the very-fine Cross Buff ™.

***Cross Buffs ™ are used to finish the combustion chamber.***

As a final-touch that will enhance engine cooling, take a small-diameter, 40-grit, straight cartridge roll or the small rotary stone and remove any casting flash that is in the coolant openings in the head decks. You will be surprised at how much of that you find.

***Most heads will have a lot of casting flash in the water crossovers. Use a small cartridge roll to remove that flash.***

***This is what a finished chamber should look like.***

## Step 6: Port Matching the Intake Manifold

***The spray Dykem is again used on the intake manifold.***

If necessary, clean the gasket surface of the intake manifold with the surface conditioning discs in the Standard Abrasives Gasket Removal Kit and apply the machinist's blue.

***The Fel-Pro intake gasket is used again to mark the manifold. You want the top of the gasket to face the manifold whereas you had the bottom of the gasket facing the head.***

Get out the intake gaskets you used to scribe the intake side of the heads and install them onto the intake manifold. Verify that the correct sides face the manifold. Scribe an outline of the inside of the intake port openings on the manifold.

Port-match the intake manifold using the cartridge rolls. If there is a lot of material inside the scribe marks to remove, use the rotary stones. If you are doing your basic port project on an engine with an aluminum manifold, remember to use a more gentle touch than you would if you were working cast iron.

***The port matching of the intake is accomplished like that of the intake port entries in the head. If a lot of material needs to be removed, start with the rotary stone, otherwise, use a 40-grit cartridge roll. Remember to use less pressure on the grinder because aluminum abrades quicker than iron.***

***The port exits in the intake manifold should feel just like the port entries in the head; slightly rough to the touch.***

## So...does it work?

DIYs are a tough crowd. Skeptics abound, so we needed a flow test of our heads before and after basic porting. We retained Valley Head Service in Northridge, California to run those tests. After our basic porting project was complete, intake port flow improved 15.3% at low valve lifts, a significant change. Average improvement, from .050 to .500-in. valve lift, was 6.3%. In the exhaust ports, gas flow at medium valve lifts improved a whopping 17%. Average improvement of exhaust flow was 7.5%. The exhaust ports showed the greatest change, which is typical of a production Chevy head. For an engine of 300 horsepower before porting, these improvements in flow would make an approximate power increase of 19hp.

Note that we did not skew the results by flowing the head after a multi-angle valve job. Our tests were done with stock valve face and seat angles. Airflow of the head after a good, high-performance valve job would improve even more.

## Final Remarks

Your basic porting project will go more smoothly if you organize your work. Dividing the job into sections will enhance your consistency and shorten time on the job by reducing the amount of tool changes.

Start on the intake port entries first. Hit them all with the rotary stone, then do the cartridge roll work. Next, do the intake bowl work. The third section of the job gets all the exhaust ports and bowls. Finish the heads by doing the chambers. Close out the whole job with the intake manifold port matching. Hold-off on having a valve job done on the heads until all abrasive operations are complete. A multi-angle valve job is best on heads destined for any high-performance application because it offers additional improvement in low-valve-lift air flow.

For more information on the high-performance abrasive products available to the DIY automotive enthusiast, click on the "products" link at the bottom of this page. You can download this whole article as a .pdf file by clicking a link at the end of it.

You also can contact us by clicking on the email link below and using the form that appears. You can call us at 800-383-6001 or you can write us at Standard Abrasives Motorsports Division, 4201 Guardian St., Simi Valley CA 93063.



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